CLAIMS

1. A method for treating a workpiece comprising the steps of:

heating the workpiece;

providing a treatment liquid onto the surface of the workpiece that is to be treated;

introducing an amount of ozone into an environment containing the workpiece.

2. A method for treating a semiconductor workpiece as claimed in claim 1 and further comprising the step of controlling the thickness of a liquid boundary layer formed by the treatment liquid on the surface of the workpiece to allow diffusion of the ozone therethrough for reaction at the surface of the workpiece.

3. A method for treating a workpiece comprising the steps of:

providing a flow of a pressurized liquid;

injecting an amount of ozone into the pressurized liquid flow;

spraying the mixture of ozone and liquid onto the workpiece.

4. A method for treating a workpiece as claimed in claim 1 wherein the liquid is deionized water.

5. A method for treating a workpiece as claimed in claim 4 wherein the deionized water is heated.

6. A method for treating a workpiece as claimed in claim 4 wherein the deionized water is superheated.

7. A method for treating a workpiece as claimed in claim 1 wherein the liquid comprises an acid.

8. A method for treating a workpiece as claimed in claim 1 wherein the liquid comprises sulfuric acid.

9. A method for treating a workpiece as claimed in claim 1 wherein the liquid comprises hydrochloric acid.

10. A method for treating a workpiece as claimed in claim 1 wherein the liquid comprises ammonium hydroxide.

11. A method for treating a workpiece as claimed in claim 1 wherein the step of spraying is further defined by spraying the liquid onto the workpiece from one or more fixed spraying positions.

12. A method for treating a workpiece as claimed in claim 11 and further comprising the step of rotating the workpiece as it is sprayed with the ozone and liquid mixture.

13. A method for treating a workpiece as claimed in claim 1 and further comprising the step of rotating the workpiece as it is sprayed with the ozone and liquid mixture.

14. A method for treating a workpiece comprising the steps of:

providing a spray of a heated liquid onto the surface of the workpiece that is to be treated;

introducing an amount of ozone into an environment containing the sprayed workpieces;

controlling the thickness of a liquid boundary layer on the surface of the workpiece to allow diffusion of the ozone therethrough for reaction at the surface of the workpiece.

15. A method for treating a workpiece as claimed in claim 14 wherein the liquid is deionized water.

16. A method for treating a workpiece as claimed in claim 15 wherein the deionized water is superheated.

17. A method for treating a workpiece as claimed in claim 14 wherein the liquid comprises sulfuric acid.

18. A method for treating a workpiece as claimed in claim 14 wherein the liquid comprises hydrochloric acid.

19. A method for treating a workpiece as claimed in claim 14 wherein the liquid comprises an acid.

20. A method for treating a workpiece as claimed in claim 14 wherein the liquid comprises ammonium hydroxide.

21. A method for treating a workpiece as claimed in claim 14 wherein the step of controlling comprises the step of rotating the workpiece.

22. A method for treating a workpiece as claimed in claim 14 wherein the step of controlling comprises the step of adding a surfactant to the liquid.

23. A method for treating a workpiece as claimed in claim 14 wherein the step of controlling comprises the step of controlling the flow of the liquid sprayed onto the surface of the wafer that is to be treated.

24. An apparatus for supplying a mixture of a treatment liquid and ozone onto the surface of a workpiece, the apparatus comprising:

a liquid reservoir having a liquid chamber;

a pump having an input in fluid communication with the liquid chamber, the pump further having an output;

one or more nozzles disposed to spray fluid therefrom onto the surface of the workpiece;

a fluid path extending between the output of the pump and the one or more nozzles, the fluid path carrying pressurized liquid provided at the output of the pump; and

an ozone supply system for injecting ozone into the fluid path.

25. An apparatus as claimed in claim 24 and further comprising a mixer disposed in the fluid path.

26. An apparatus as claimed in claim 25 wherein the mixer is a static mixer.

27. An apparatus as claimed in claim 25 wherein the mixer is an active mixer.

28. An apparatus as claimed in claim 24 wherein the pressurized liquid is deionized water.

29. An apparatus as claimed in claim 24 wherein the pressurized liquid comprises sulfuric acid.

30. An apparatus as claimed in claim 24 wherein the pressurized liquid comprises ammonium hydroxide.

31. An apparatus as claimed in claim 24 wherein the pressurized liquid comprises an acid hydroxide.

32. An apparatus as claimed in claim 24 wherein the pressurized liquid comprises hydrochloric acid.

33. An apparatus as claimed in claim 24 wherein the liquid reservoir comprises an inlet for supplying ozone into a liquid chamber of the liquid reservoir, the liquid chamber being in fluid communication with the pump.

34. An apparatus as claimed in claim 33 wherein the inlet for supplying ozone is in fluid communication with the ozone generator

35. An apparatus as claimed in claim 33 wherein the liquid reservoir further comprises and ozone dispersion apparatus disposed in the liquid chamber for dissolving ozone received at the inlet in liquid contained within the liquid chamber.

36. An apparatus as claimed in claim 24 and further comprising a chamber for housing the workpiece as it is sprayed with treatment liquid that proceeds from the one or more nozzles.

37. An apparatus as claimed in claim 36 and further comprising a re-circulation fluid path extending between the chamber and the liquid reservoir.

38. An apparatus as claimed in claim 36 and further comprising a rotor assembly disposed in the chamber for rotating the workpiece.

39. An apparatus for providing a mixture of ozone and a liquid comprising water for treatment of the surface of a workpiece, the apparatus comprising:

a reservoir having a chamber holding the liquid comprising water;

a pump having an input connected to receive the liquid comprising water from the chamber of the reservoir, the pump further having an output for supplying pressurized liquid comprising water therefrom;

one or more nozzles disposed to spray fluid therefrom onto the surface of the workpiece;

a fluid path extending between the output of the pump and the one or more nozzles, the fluid path carrying the pressurized liquid comprising water that is provided at the output of the pump; and

an ozone generator for generating a supply of ozone at an output thereof;

one or more supplying lines extending from the ozone generator to the fluid path for injecting ozone into the fluid path.

40. An apparatus as claimed in claim 39 and further comprising a mixer disposed in the fluid path.

41. An apparatus as claimed in claim 40 wherein the mixer is a static mixer.

42. An apparatus as claimed in claim 40 wherein the mixer is an active mixer.

43. An apparatus as claimed in claim 39 wherein the reservoir comprises an inlet for supplying ozone into the chamber of the reservoir.

44. An apparatus as claimed in claim 43 wherein the inlet for supplying ozone is in fluid communication with the ozone generator

45. An apparatus as claimed in claim 39 wherein the reservoir further comprises an ozone dispersion apparatus disposed in the chamber for dissolving ozone received at the inlet in the liquid comprising water contained within the chamber.

46. An apparatus as claimed in claim 39 and further comprising a chamber for housing the workpiece as it is sprayed with the liquid comprising water that proceeds from the one or more nozzles.

47. An apparatus as claimed in claim 46 and further comprising a re-circulation fluid path extending between the chamber housing a workpiece and the chamber of the reservoir.

48. An apparatus as claimed in claim 46 and further comprising a rotor assembly disposed in the chamber for rotating the workpiece.

49. An apparatus for supplying a mixture of a treatment liquid and ozone for treatment of a surface of a workpiece, the apparatus comprising:

means for heating the workpiece;

means for spraying the treatment liquid onto the surface of the workpiece;

means for introducing ozone into an environment containing the workpiece;

means for controlling the thickness of a boundary layer of the treatment liquid on the surface of the workpiece to thereby facilitate diffusion of the ozone to the surface of the workpiece.

50. An apparatus as claimed in claim 49 wherein the means for heating comprises a heater disposed to heat the treatment liquid that is applied to the workpiece.

51. An apparatus as claimed in claim 49 wherein the means for controlling comprises a rotor disposed to rotate the workpiece.

52. An apparatus as claimed in claim 49 wherein the means for controlling comprises means for controlling the flow of treatment liquid applied to the surface of workpiece.

53. An apparatus as claimed in claim 49 wherein the means for controlling the flow of treatment liquid applied to the surface of the workpiece comprises a pump.

54. An apparatus as claimed in claim 49 wherein the means for controlling comprises one or more nozzles adapted to generate fine droplets of the treatment liquid.

55. An apparatus as claimed in claim 49 wherein the treatment liquid is deionized water.

56. An apparatus as claimed in claim 49 wherein the treatment liquid comprises an acid.

57. An apparatus as claimed in claim 49 wherein the treatment liquid comprises sulfuric acid.

58. An apparatus as claimed in claim 49 wherein the treatment liquid comprises hydrochloric acid.

59. An apparatus as claimed in claim 49 wherein the treatment liquid comprises ammonium hydroxide.

60. An apparatus as claimed in claim 55 wherein the means for heating comprises a steam boiler.

61. An apparatus as claimed in claim 49 wherein the treatment liquid is an aqueous solution comprising water.

62. An apparatus as claimed in claim 61 wherein the means for heating comprises a steam boiler.

63. An apparatus for supplying a mixture of a treatment liquid and ozone for treatment of a surface of a workpiece, the apparatus comprising:

a heater disposed to heat the workpiece;

a reservoir;

a treatment chamber housing the workpiece;

a liquid supply line providing fluid communication of the treatment liquid between the reservoir and the treatment chamber;

one or more nozzles accepting treatment liquid from the liquid supply line and spraying the treatment liquid onto the surface of the workpiece;

an ozone generator having an output line for providing ozone into an environment containing the workpiece;

means for controlling the thickness of a boundary layer of the heated treatment liquid on the surface of the workpiece to thereby facilitate diffusion of the ozone to the surface of the workpiece.

64. An apparatus as claimed in claim 63 wherein the heater indirectly heats the workpiece by a heating the treatment liquid that is sprayed thereon.

65. An apparatus as claimed in claim 63 wherein the treatment liquid is deionized water.

66. An apparatus as claimed in claim 63 wherein the treatment liquid comprises an acid.

67. An apparatus as claimed in claim 63 wherein the treatment liquid comprises sulfuric acid.

68. An apparatus as claimed in claim 63 wherein the treatment liquid comprises hydrochloric acid.

69. An apparatus as claimed in claim 63 wherein the treatment liquid comprises ammonium hydroxide.

70. An apparatus as claimed in 63 wherein the treatment liquid is an aqueous solution comprising water.

71. An apparatus as claimed in claim 63 wherein the output line of the ozone generator is connected to the liquid supplying line.

72. An apparatus as claimed in claim 63 wherein the output line of the ozone generator is connected to the treatment chamber.

73. An apparatus as claimed in claim 63 wherein the heater is connected in-line with the liquid supplying line.

74. An apparatus as claimed in claim 63 wherein the heater is disposed in the reservoir.

75. An apparatus as claimed in claim 63 wherein the means for controlling comprises a rotor disposed to rotate the workpiece.

76. An apparatus as claimed in claim 63 wherein the means for controlling comprises means for controlling the flow of treatment liquid through the liquid supply line.

77. An apparatus as claimed in claim 63 wherein the means for controlling the flow of treatment liquid through the liquid supply line comprises a pump.

78. An apparatus as claimed in claim 63 wherein the means for controlling comprises one or more nozzles adapted to generate fine droplets of the treatment liquid.

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